Fission Multipliers for D-D/D-T Neutron Generators*

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ABSTRACT

A compact D-D/D-T fusion-based neutron generator is being designed at the Lawrence Berkeley National Laboratory to have a potential yield of 10^{12} D-D n/s and 10^{14} D-T n/s. Because of its high neutron yield and compact size (~20 cm in diameter by 4 cm long), this neutron generator will be suitable for many applications. However, some applications require higher flux available from nuclear reactors and spallation neutron sources operated with GeV proton beams. In this study, a subcritical fission multiplier with k_{eff} of 0.98 is coupled with the compact neutron generators, in order to increase the neutron flux output. We have chosen two applications to show the gain in flux due to the use of fission multipliers – in-core irradiation and out-of-core irradiation. For the in-core irradiation, we have shown that a gain of ~30 can be achieved in a positron production using a D-T neutron generator. For the out-of-core irradiation, the gain of ~10 times is obtained in BNCT (Boron Neutron Capture Therapy) using a D-D neutron generator. The total number of fission neutrons generated by a source neutron in a fission multiplier with k_{eff}=0.98 is 50. For the in-core irradiation, the theoretical multiplication is ~50. For the out-of-core irradiation, the theoretical maximum net multiplication is ~30 due to the absorption of neutrons in the fuel. A discussion of the achievable multiplication and the theoretical multiplication will be presented in this paper.

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